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BULLETIN No. 39

INSECTS AND A MITE FOUND ON COTTON IN PUERTO RICO, WITH NOTES ON THEIR ECONOMIC IMPORTANCE AND NATURAL ENEMIES

By

L. COURTNEY FIFE

Assistant Entomologist, Division of Cotton Insect Investigations, Bureau of Entomology and Plant Quarantine

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INSECTS AND A MITE FOUND ON COTTON IN PUERTO RICO, WITH NOTES ON THEIR ECONOMIC IMPORTANCE AND NATURAL ENEMIES [1]

By L. COURTNEY FIFE, *Assistant Entomologist, Division of Cotton Insect Investigations, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture* [2]

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Insect damage is an important factor in limiting the production of sea-island cotton in Puerto Rico. A knowledge of the various insect species involved is essential before any practical methods for their control can be determined. A few observations were made prior to 1920, but since that date the economic status of many of the species has changed and several other species not then recorded are now serious pests. Although the damage by many species is not extensive, the collective damage by all concerned is significant.

LIST OF PESTS AND THEIR NATURAL ENEMIES

The insects found by the writer on cotton in Puerto Rico during 1935, 1936, and 1937, together with those reported by other writers,

[1] The determinations for the various species of insects and the mite mentioned in this bulletin have been supplied by the Division of Insect Identification of the Bureau of Entomology and Plant Quarantine.

[2] Working in cooperation with the Puerto Rico Experiment Station of the U. S. Department of Agriculture.

are here discussed in the sequence of their economic importance under orders and families as shown in the following list:

LEPIDOPTERA

Gelechiidae:
Pectinophora gossypiella (Saund.)
Parasites: *Chelonus blackburni* Cam. (Introduced)
Exeristes roborator (F.) (Introduced)
Microbracon kirkpatricki Wilk. (Introduced)
Perisierola, n. sp., near *nigrifemur* (Ashm.)
Predator: *Solenopsis geminata* F.
Noctuidae:
Alabama argillacea (Hbn.)
Parasites: *Apanteles aletiae* Riley
Brachymeria incerta (Cress.)
Sarcophaga lambens Wied.
Anomis doctorium Dyar
Feltia subterranea (F.)
Heliothis virescens (F.)
Parasite: *Sarcophaga lambens* Wied.
Laphygma frugiperda (A. and S.)
L. sunia (Guen.)
Prodenia dolichos (F.)
P. pulchella (H. S.)
Pyralidae:
Corcyra cephalonica (Staint.)
Ephestia cautella (Walk.)
Parasite: *Microbracon hebetor* (Say)
Nepticulidae:
Nepticula gossypii F. and L.
Cosmopterygidae:
Pyroderces rileyi (Wlsm.)
Parasites: *Perisierola nigrifemur* (Ashm.)
Spilochalcis flavopicta (Cress.)

HEMIPTERA

Pyrrhocoridae:
Dysdercus andreae (L.)
D. sanguinarius Stål
Pentatomidae:
Acrosternum marginatum (P. B.)
Loxa planifrons Barber and Bruner
Mormidea cubrosa (Dallas)
Nezara viridula (L.)
Piezodorus guildinii (Westw.)
Podisus sagitta (F.)
Thyanta perditor (F.)
Miridae:
Creontiades rubrinervis (Stål)
Lygus apicalis Fieb.
Polymerus cuneatus (Dist.)
Coreidae:
Catorhintha guttula (F.)
Chariesterus gracilicornis Stål
Corizus hyalinus (F.)
C. sidae (F.)
Leptocorisa filiformis (F.)
Magalotomus rufipes (Westw.)
Lygaeidae:
Lygaeus collaris F.
Oncopeltus aulicus (F.)
Orthaea bilobata (Say)
Tingitidae:
Corythaica carinata Uhler
Corythucha gossypii (F.)

HOMOPTERA

Coccidae:
- *Asterolecanium pustulans* (Ckll.)
- *Aulacaspis pentagona* (Targ.)
- *Ceroplastes denudatus* Ckll.
- *Hemichionaspis minor strachani* Cooley
- *Pinnaspis buxi* (Bouché)
- *Saissetia hemisphaerica* (Targ.)
- *S. nigra* (Nietn.)
- *S. oleae* (Bern.)
- *Pseudococcus brevipes* (Ckll.)
- *P. citri* (Risso)
- *P. longispinus* (Targ.)
- *P. virgatus* (Ckll.)
- *Phenacoccus gossypii* T. and C.

Aphiidae:
- *Aphis gossypii* Glov.
  - Parasite: *Lysiphlebus testaceipes* (Cress.)
  - Predators: *Baccha clavata* F.
    - *B. latiusculus* Loew
    - *Chrysopa* sp.
    - *Cryptolaemus montrouzieri* Muls. (Introduced)
    - *Cycloneda sanguinea* var. *limbifer* Csy.
    - *Diomus floralis* (F.)
    - *Hippodamia convergens* (Guer.) (Introduced)
    - *Hyperaspis festiva* Muls.
    - *H. connectens* (Thunb.)
    - *Psyllobora nana* Muls.
    - *Scymnus loewii* Muls.
    - *S. roseicollis* Muls.
    - *Scymnus* sp.

Cicadellidae:
- *Agallia albidula* Uhler
- *Cicadella similis* (Walk.)
- *C. sirena* (Stål)
- *Empoasca gossypii* Del.
- *Poeciloscarta histrio* (F.)
- *Xerophloea viridis* (F.)

Fulgoridae.
- *Oliarus complectus* Ball

COLEOPTERA

Curculionidae:
- *Apodrosus argentatus* Wolcott
- *Chalcodermus* sp.
- *Diaprepes abbreviatus* var. *doublieri* Guer.
- *Exophthalmodes roseipes* (Chev.)
- *Lachnopus curvipes* (F.)

Chrysomelidae:
- *Cryptocephalus nigrocinctus* Suff.
- *C. tristiculus* Weise
- *Cryptocephalus* sp.
- *Diabrotica graminea* Baly
- *Hilarocassis exclamationis* (L.)
- *Metachroma antennalis* Weise
- *Myochrous* sp.
- *Nodonota* sp.
- *Systena basalis* Duv.
- *S. varia* Weise

Cerambycidae:
- *Ataxia alboscutellata* Fisher
  - Parasite: *Ipobracon* sp.

Tenebrionidae:
- *Blapstinus striatulus* Muls. and Rey
- *Tribolium confusum* J. d. V.
- *T. castaneum* (Hbst.)

THYSANOPTERA

Thripidae:
Frankliniella insularis (Frankl.)
Heliothrips haemorrhoidalis (Bouché)
Phlaeothripidae:
Haplothrips gowdeyi (Frankl.)

ORTHOPTERA

Gryllidae:
Gryllus assimilis (F.)
Scapteriscus vicinus Scudder

COLLEMBOLA

Entomobryidae:
Entomobrya cubensis Fols.
Salina wolcotti Fols.
Salina sp.

ACARINA

Eriophyidae:
Eriophyes gossypii Banks

LEPIDOPTERA

Gelechiidae.—The pink bollworm (*Pectinophora gossypiella*) since its introduction in 1921 has been the only species of this family causing serious injury to cotton. It probably destroys from 30 to 50 percent of the crop annually. Owing to its economic importance, it has been studied more than any other cotton pest, particularly by Bartlett;[3] Camuñas (*3*);[4] Catoni (*4*, *5*, *6*, *7*); Fife (*9*, *10*); Legrand (*16*, *17*); Leonard (*18*, *19*, *20*); Luciano (*21*); Mellado (*22*, *23*); More (*24*); Pastor Rodríguez (*26*, *27*, *28*, *29*); Saavedra (*32*); Torres (*34*, *35*); Wolcott (*38*, *39*, *40*, *41*, *42*, *43*); and Wolcott et al. (*44*, *45*). These writers give general accounts of its damage, life history, habits, host plants, and parasites, and of control measures against it. Numerous control measures have been advocated, i. e., enforcement of a uniform dead season in cotton production, destruction of crop remnants, eradication of wild cotton and other favorable alternate host plants, short growing periods, elimination of companion cropping, seed treatment, etc.

The only known native beneficial insects which aid in the biological control of the pink bollworm in Puerto Rico are a small bethylid, *Perisierola*, n. sp., near *nigrifemur*, and the fire ant (*Solenopsis geminata*). Neither of these insects is effective in holding it in check. Since Puerto Rico is an insular area with a semitropical climate, it is an ideal place for the introduction and colonization of beneficial insects. Through the cooperation of the Divisions of Cotton Insect Investigations and Foreign Parasite Introduction of the Bureau of Entomology and Plant Quarantine three species of pink bollworm parasites were introduced during 1935, 1936, and 1937, namely, *Exeristes roborator*, *Microbracon kirkpatricki*, and *Chelonus blackburni*. These parasites were reared by L. W. Noble and W. T. Hunt at the Presidio, Tex., station of the Division of Cotton Insect Investigations, and were received and liberated by K. A. Bartlett of the Puerto Rico Experiment Station.[5] A summary of this work up to 1936 has

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[3] BARTLETT, KENNETH A. THE INTRODUCTION AND COLONIZATION IN PUERTO RICO OF BENEFICIAL INSECTS PARASITIC ON THE PINK BOLLWORM OF COTTON. Puerto Rico Agr. Expt. Sta. Agr. Notes 77, 5 pp. 1937. [Mimeographed.]

[4] Italic numbers in parentheses refer by authors to Literature Cited, p. 12.

[5] Formerly assistant entomologist in the Division of Foreign Parasite Introduction of the Bureau of Entomology and Plant Quarantine.

already been reported by Bartlett;[6] further records obtained through him are given in table 1. This table shows the liberations of pink bollworm parasites made in Puerto Rico, with species, localities, and numbers liberated.

TABLE 1.—*Liberation of introduced parasites of the pink bollworm in Puerto Rico, 1935–37*

Species	Locality	Date of liberation	Adults liberated
			Number
Exeristes roborator [1]	Camuy	October 1935	1,592
Do	Isabela	May to July 1936	1,251
Do	Boquerón	April 1937	5,722
Microbracon kirkpatricki [2]	Camuy	October and November 1935	35,528
Chelonus blackburni [3]	Isabela	May to July 1936	13,586
Do	do	June and July 1937	8,871
Do	Quebradillas	June 1937	5,941
Do	Camuy	do	9,800
Do	Hatillo	do	4,848
Do	Boquerón	May and June 1937	13,237

[1] Total liberated, 8,565.
[2] Total liberated, 35,528.
[3] Total liberated, 56,283.

Dr. Bartlett reports that all species were recovered at points of liberation within a few months after they were released, but only by continued observations during the coming years can the importance of these introduced parasites in the biological control of the pink bollworm be determined.

Noctuidae.—Several species of this family cause injury to cotton, but the most important one in Puerto Rico is the cotton leaf worm (*Alabama argillacea*). Its population density per unit area varies considerably at different periods of the year and at any given time in closely adjacent localities. Farmers often find it necessary to use arsenicals in effecting its control. Since Puerto Rico has two cotton sections with seasons at opposite periods of the year, the cotton leaf worm is able to find suitable food at any time. In September, October, and November 1935, it caused considerable injury to young cotton plants at Sabana Grande and Boquerón on the south coast, and again in June and July 1936 at Isabela, Camuy, and Arecibo on the north coast. Another outbreak also occurred at Boquerón on the south coast from November 1937 to January 1938, but the damage was not extensive.

On the south coast, an area of light rainfall, an abundance of caterpillars on the young plants may cause a severe loss. If rains do not follow the incursion of the caterpillars, the plants have no reserves for sending out a new set of leaves and as a result they either die or develop only a few squares and bolls. Even when favorable rains are encountered the main crop is still delayed 2 or 3 weeks by the damage, thereby subjecting it to a heavier infestation by other insect pests.

The cotton leaf worm was found continuously from August 1935 to January 1938, which shows that this pest may be active over winter in this area. Wolcott reports its presence in Puerto Rico for several years continuously, and then its absence for a series of years.

[6] BARTLETT, KENNETH A. See footnote 3.

Audant (*1*) also records its presence in Haiti during the winter months.

Numerous parasites have been recorded as attacking the cotton leaf worm in various parts of the world. Two pupal parasites were the only beneficial species reared by the author from Puerto Rico, namely, *Brachymeria incerta* and *Sarcophaga lambens*. Of 380 pupae of *Alabama argillacea* collected at Isabela in July 1936, 7, or 1.8 percent, were parasitized by *B. incerta* and 16, or 4.2 percent, by *S. lambens*. Also, of 100 pupae of the cotton leaf worm collected at Boquerón in February 1936, 10 percent were parasitized by *B. incerta*. Wolcott (*43*) also records *Apanteles aletiae* Riley as attacking the small larvae and *S. sternodontis* Towns. (=*S. lambens* Wied.) as attacking the pupae of this species.

Four different species of armyworms (*Laphygma frugiperda*, *L. sunia*, *Prodenia pulchella*, and *P. dolichos*) have been reared from larvae collected on cotton, but they seldom, if ever, become sufficiently numerous to be of much importance. Considerable losses have been caused, however, by *L. frugiperda* and *L. exigua* in the United States and in northern Mexico.

A soil-inhabiting cutworm, *Feltia subterranea*, became abundant in fields of young seedling cotton in August and September 1937 at Boquerón. This species hides in the ground in the daytime and sallies forth at night to feed, cutting off the stems of the young plants just below the surface of the ground and feeding on the leaves. Many acres of cotton were replanted two or three times in this area because of attacks of this pest. Serious damage to cotton by *F. malefida* (Guen.) has been observed by the writer in Texas. Smyth (*33*) also reports the tropical cutworm (*Xylomiges sunia* Guen.=*Laphygma sunia* (Guen.)) as attacking cotton.

Although the bollworm (*Heliothis obsoleta* (F.)) is a serious pest of cotton in the United States and of corn in Puerto Rico, it has not been observed by the author attacking cotton in Puerto Rico.

Moths of the tobacco budworm (*Heliothis virescens*) have been reared from larvae collected on cotton, but rarely, if ever, does it become a pest. Folsom (*13*), however, reports that this species at times becomes a rather serious pest of cotton in southern parts of the United States. This insect was found to be numerous on *Abutilon hirtum* at Guánica, Lajas, and Boquerón in November 1935. It was found to be parasitized by *Sarcophaga lambens*.

Several species of *Anomis* have been reported as pests of cotton in various parts of the world. Wolcott (*43*) records one species, *Anomis doctorium*, as attacking cotton in Puerto Rico. Creighton (*8*) reports that *A. erosa* Hbn. causes considerable damage to cotton in Florida; Rainwater (*31*) reports the presence of *A. flava fimbriago* (Steph.) on cotton in South Carolina and (*30*) of *A. impasta* Guen. on wild cotton in Florida. In Puerto Rico the writer has found *A. erosa* feeding on *Sida cordifolia* and *A. illita* Guen. on *Malachra capitata*, each species being numerous on their respective hosts. It is likely that these two species attack cotton to a limited extent on the island.

Pyralididae.—Two species of pyralids were found attacking stored cottonseed, namely, *Ephestia cautella* and *Corcyra cephalonica*. The former species attacks only cottonseed that has been cracked in the

process of ginning. The numbers of this insect in stored cottonseed are, therefore, governed to a large extent by the proportion of cracked seed. The eggs are laid on or among the cottonseed, and the first-instar larvae gain entrance into the seed through the cracked hull and hollow out its contents. Pupation occurs inside the seed or in the lint surrounding the seed. The larvae of this species were rather heavily parasitized by *Microbracon hebetor.*

Corcyra cephalonica was not found numerous in the stored cottonseed, and therefore the damage it causes is negligible. Wolcott (*43*) reports its presence in cottonseed cake.

Nepticulidae.—The cotton leaf miner (*Nepticula gossypii*) was first described and reported as a pest of cotton by Forbes and Leonard (*14*). They found it present throughout the commercial cotton-growing area on the south coast, in many fields almost 100 percent of the leaves being infested. Little premature shedding of the foliage was observed, however, even on plants severely infested. In January 1936 observations on the south coast, where cotton had not been grown commercially for 3 years, showed this species to be present in limited numbers on cotton only at Boquerón. Wolcott (*43*) also records its presence on the leaves of the hollyhock (*Althaea rosea*) at Rio Piedras. Rainwater (*30*) reports the presence of this pest on wild cotton in southern Florida, in some cases 100 percent of the leaves being infested, resulting in severe shedding of the foliage.

Cosmopterygidae. The pink scavenger worm (*Pyroderces rileyi*) feeds only in partly decayed bolls found on the plants or on the ground and consequently causes no injury to cotton. The mature larvae may be mistaken for the pink bollworm. It was numerous in all commercial cotton-growing districts of the island. The pupal stage is parasitized by *Spilochalcis flavopicta.* Wolcott (*43*) also records *Perisierola nigrifemur* as a parasite of this insect.

HEMIPTERA

Pyrrhocoridae.—Two species belonging to this family cause serious injury to cotton throughout the island, namely, *Dysdercus sanguinarius* and *D. andreae;* both species are commonly called La Unión, as they are frequently found in copulation. The former species is most abundant along the north coast while the latter is more numerous in the arid areas of the south coast. The adults and nymphs of both species are gregarious but are constantly moving; therefore the population density is never uniform in a field. *D. sanguinarius* was also found numerous on maga (*Montezuma speciosissima*) and to a lesser extent on clamor (*Thespesia populnea*). The most favorable host of *D. andreae* is *Thespesia populnea*, on which it may be found during the entire year; *Abutilon hirtum* and *Sida* sp. also serve as hosts.

The injury to cotton caused by pyrrhocorids and pentatomids is essentially the same and is limited largely to bolls. The feeding of these insects causes the lint to become reddish brown and as a result almost worthless. A proliferation of plant tissue takes place on the inner side of the carpel at the point of entrance of the insect's mouth parts. In general, damaged bolls when open are characterized by partially spreading carpels and shriveled locks. Cotton locks may

be perfect except for a small stained patch of lint which, however slight, offsets the value of the unstained product. Young green bolls when severely attacked by these bugs may flare, turn yellowish, become flaccid, and fall to the ground.

To determine the amount of damage caused by the boll-feeding group of pyrrhocorids, pentatomids, and other hemipterous insects, mature, green bolls were examined throughout the cotton-growing districts of Puerto Rico during 1935, 1936, and 1937. The results are shown in table 2.

TABLE 2.—*The percentage of mature, green bolls on sea-island cotton injured by various species of hemipterous insects*[1] *on the north and south coasts of Puerto Rico, 1935–37*

Area	Date examined	Fields sampled	Average number of bolls examined per field	Bolls injured		
				Average	Maximum	Minimum
		Number		*Percent*	*Percent*	*Percent*
North coast [2]	September 1935	12	127.8	14.1	50	4
Do	June 1936	24	93.3	18.7	82	0
Do	August 1936	24	97.3	25.7	76	1
South coast [3]	March 1936	9	100.0	25.4	75	8
Do [4]	April 1937	9	100.0	16.6	30	6
Total or average		78	103.7	20.1	82	0

[1] Caused mainly by various species of pyrrhocorids and pentatomids, the most important species being *Dysdercus sanguinarius, D. andreae, Nezara viridula, Acrosternum marginatum, Thyanta perditor, Piezodorus guildinii,* and *Mormidea cubrosa.*

[2] Samples taken at Aguadilla, Isabela, Quebradillas, Camuy, Hatillo, and Acrecibo.

[3] Samples taken at Boquerón and Lajas.

[4] Samples taken only at Boquerón.

Of 8,088 bolls examined from 78 fields, the number of mature green bolls punctured averaged 20.1 percent and ranged from 0 to 82 percent. On the south coast, in April 1937, the injured bolls and locks were recorded separately. Of 900 bolls examined, the percentage injured ranged from 6 to 30, averaging 16.6; the percentage of injured locks ranged from 3 to 19, averaging 9. The staining and discoloration of the lint caused by boll-feeding habits of various hemipterous insects referred to above materially reduces the grade of the entire crop and, therefore, its value.

Pentatomidae.—The insects of this group are not so important as the pyrrhocorids, yet they cause considerable damage to sea-island cotton. Six species were found associated with cotton, namely, *Nezara viridula*, *Acrosternum marginatum*, *Thyanta perditor*, *Podisus sagitta*, *Piezodorus guildinii*, and *Mormidea cubrosa*. *N. viridula* and *T. perditor* have also been reported by Morrill (*25*) as causing serious injury to cotton on the mainland. However, the exact economic status of these species on cotton in Puerto Rico has not been determined. Wolcott (*43*) also records the presence of *Loxa planifrons* on cotton.

Miridae.—Two species of this family (*Lygus apicalis* and *Creontiades rubrinervis*) were found on cotton. The latter species was numerous in certain localities on the south coast, especially in fields where companion cropping with corn was practiced. A detailed study was not made of their feeding habits on cotton, but it is likely that they puncture very small squares, which then become blasted and

are shed, thereby preventing the formation of flowers. Wolcott (*43*) also reports the presence of *Polymerus cuneatus* on cotton in Puerto Rico. Folsom (*12*) reports serious damage to cotton on the mainland by three closely related species, *C. debilis* Van D., *L. pratensis* (L.), and *L. elisus* Van. D.

Coreidae.—Although the nature and extent of damage to cotton by various insects of this family have not been investigated, the following species were found to be present: *Magalotomus rufipes*, *Catorhintha guttula*, *Corizus hyalinus*, *Corizus sidae*, *Leptocorisa filiformis*, and *Chariesterus gracilicornis*. Since Morrill (*25*) reports serious damage to cotton by closely related species in the United States, it is believed that the above-mentioned insects are of some economic importance in Puerto Rico.

Lygaeidae.—Three species of Lygaeidae were collected in cotton-fields, namely, *Oncopeltus aulicus*, *Lygaeus collaris*, and *Orthaea bilobata*. Morrill (*25*) has reported that closely related species attack both cotton squares and bolls in Texas.

Tingitidae.—Two species of lacebugs (*Corythucha gossypii* and *Corythaica carinata*) were found occasionally on cotton, but the damage caused by either of these species is negligible.

Miscellaneous Hemiptera.—*Diolcus irroratus* (F.), of the family Pentatomidae, *Zelus longipes* (L.) of the Reduviidae, and *Nabis capsiformis* Germ. of the Nabidae, were commonly found in cotton-fields, but no observations were made of their feeding habits.

HOMOPTERA

Coccidae.—Scale insects were commonly found on cultivated cotton. *Hemichionaspis minor strachani*, *Ceroplastes denudatus*, *Saissetia oleae*, *S. hemisphaerica*, and *S. nigra* were collected by the writer. Wolcott (*43*) also reports the presence of *Aulacaspis pentagona*, *Asterolecanium pustulans*, and *Pinnaspis buxi* on cotton. These species become most numerous on cotton plantings late in the season but never become abundant enough to attain an economic status. It appears that scale insects will become abundant on cotton only when the plant is a perennial, and thus a longer period for the spread of the colonies is provided. *H. minor strachani* was also found abundant on *Thespesia populnea* and on the trunks of wild tree cotton.

Three species of mealybugs (*Pseudococcus virgatus*, *P. brevipes*, and *P. citri*) were found on cotton but none abundant enough to cause noticeable injury. Wolcott (*43*) also reports the presence of *Phenacoccus gossypii* and Smyth (*33*) *Pseudococcus longispinus*. They also found them more abundant on older plantings of cultivated cotton and on perennial wild tree cotton. All species were found more numerous on the north coast than in the arid areas of the south.

Aphiidae.—The cotton aphid (*Aphis gossypii*) occurs throughout the commercial cotton districts of the island. However, heavy rains, parasites, and numerous predators are effective checks on its abundance. It was found heavily parasitized by *Lysiphlebus testaceipes*. Among the predators, *Baccha clavata* and *Chrysopa* sp. were found the most important. The control effected by *B. clavata* was to a large extent annulled by the action of a secondary pupal parasite, *Pachyneuron allograptae* Ashm. Various coccinellids were found

rather abundant on cotton and are known to be important factors limiting the abundance of aphids and mealybugs in cottonfields. The following species were found to be present: *Cryptolaemus montrouzieri*, *Cycloneda sanguinea* var. *limbifer*, *Hyperaspis connectens*, *Psyllobora nana*, *Scymnus roseicollis*, and *Scymnus* sp. *Cryptolaemus* probably attacks all mealybugs belonging to the genus *Pseudococcus* but it was not numerous. Van Dine (*36*) records the introduction of *C. montrouzieri* into Puerto Rico from California in 1911 to aid in the control of the sugarcane mealybug. Wolcott (*43*) also reports the following coccinellid predators of the cotton aphid: *Hippodamia convergens*, *Hyperaspis festiva*, *H. connectens*, *S. loewii*, and *Diomus floralis*. He also reports the presence of a syrphid, *Baccha latiusculus*. Hooker (*15*) reports that *Hippodamia convergens* was introduced from California to aid in the control of aphids.

Cicadellidae.—Six species of leafhoppers were found on cultivated cotton, namely, *Empoasca gossypii*, *Cicadella sirena*, *C. similis*, *Agallia albidula*, *Poeciloscarta histrio*, and *Xerophloea viridis*. Occasionally *E. gossypii* becomes abundant enough to attain an economic status, particularly on the south coast. Leafhoppers habitually puncture the stem and leaves, from which they extract large quantities of sap, but the plant seems to withstand this loss of sap, and injury from these insects is apparently slight.

Fulgoridae.—*Oliarus complectus*, found in limited numbers on cotton, was the only species of this family collected.

COLEOPTERA

Curculionidae.—All the beetles of this family found on cotton cause some injury by eating large circular holes out of the leaves, flower bracts, and squares. The following species were found fairly numerous and were rather widely distributed: *Lachnopus curvipes*, *Diaprepes abbreviatus* var. *doublieri*, *Chalcodermus* sp., *Exophthalmodes roseipes*, and *Apodrosus argentatus*.

Chrysomelidae.—Six species of leaf beetles were found in limited numbers attacking the leaves of cultivated cotton, namely, *Diabrotica graminea*, *Systena basalis*, *Hilarocassis exclamationis*, *Cryptocephalus* sp., *Myochrous* sp., and *Nodonota* sp. Wolcott (*43*) reports that *S. varia* occasionally becomes a serious pest of cotton in Puerto Rico. He also reports that *C. nigrocinctus*, *C. tristiculus*, and *Metachroma antennalis* attack cotton to a certain extent.

Cerambycidae.—The borer *Ataxia alboscutellata* was found tunneling in the main stem and smaller branches of old cotton stalks bearing green leaves at Sabana Grande. In one field 11.3 percent of the stalks were found infested while in another only 0.67 percent were tunneled. The larvae were found lightly parasitized by *Ipobracon* sp.

Tenebrionidae.—Insects belonging to this family found by the author were not causing injury to cotton. Wolcott (*43*), however, reports that *Blapstinus striatulus* attacks sprouting cotton seedlings. He also reports the presence of *Tribolium confusum* and *T. castaneum* in cottonseed meal.

THYSANOPTERA

Thripidae and Phlaeothripidae.—The greenhouse thrips (*Heliothrips haemorrhoidalis*) was found abundant on cultivated cotton along

the north coast during 1935, but was scarce in this same area in 1936 and 1937. Wild cotton was generally found heavily infested. The larvae and adults are found on the outside of the bolls or underneath the calyx, where they scar the surface and cause white abrasions that later turn brown. Smyth (*33*) reports that the injury caused by this species seems "to be immediately concerned in the attack of a disease that somewhat discolors the bolls and causes the calyx to cement itself to the outside of the boll, preventing the latter from bursting properly." In 1935, when this species was abundant, only a few bolls were noted by the writer that checked with these observations. Of 16 fields examined along the north coast between Aguadilla and Camuy in December 1935 the injured bolls per field ranged from 5 to 79 percent, averaging 28.5 percent.

Two other species of thrips of slight importance were found on cotton, namely, *Frankliniella insularis* and *Haplothrips gowdeyi*.

ORTHOPTERA

Gryllidae.—In February 1937 the West Indian mole cricket (*Scapteriscus vicinus*) caused damage to young cotton seedlings at Isabela. The attacks of this pest were confined to plantings in sandy soil and less than 5 percent of the young plants were destroyed by the cutting off of the main stem or roots just below the soil surface. Leonard (*20*) reports that considerable damage was caused by this pest in 1931 at Isabela. Pastor Rodríguez (*29*) recommends the planting of an extra amount of seed in order to allow for this pest in cottonfields. Wolcott (*43*) records the presence of *Gryllus assimilis* in cottonfields.

DIPTERA

Cecidomyiidae.—Although Ballou (*2*), Wilson (*37*), and Rainwater (*30*) report damage to cotton caused by the flower-bud maggot (*Contarinia gossypii* Felt) in Antigua, St. Croix, and Florida, it was not found by the writer in Puerto Rico.

COLLEMBOLA

Entomobryidae.—At Quebradillas during June 1935 three species of springtails were numerous on the under side of cotton leaves, namely, *Entomobrya cubensis*, *Salina wolcotti*, and *Salina* sp. The economic importance of these species in cottonfields is not known.

ACARINA

Eriophyidae.—The West Indian blister mite (*Eriophyes gossypii*) constitutes one of the major cotton pests. In 1936–37 a few fields were completely destroyed and many others were severely damaged throughout the commercial cotton-growing districts as a result of the attack of this mite. Damage was found most severe in fields in which the attack began on the young growing plants, and in such cases the development of fruiting forms may be entirely prevented. Its early history in the West Indies, nature and extent of injury to sea-island cotton, and methods of control have already been recorded by Ballou (*2*), Wilson (*37*), and Fife (*11*).

SUMMARY

The insect pests and a mite found on cotton in Puerto Rico are discussed, with notes on their economic importance and natural control.

The pink bollworm of cotton is the most serious pest, and it probably destroys from 30 to 50 percent of the crop annually.

Several leaf feeders are present in the fields, but the most common species is the cotton leaf worm. An abundance of the caterpillars on the young plants may cause a severe loss, especially in areas of light rainfall.

Four species of armyworms are present, but they seldom if ever become sufficiently numerous to be of any importance.

Although the bollworm (*Heliothis obsoleta*) is a serious pest of corn it seldom attacks cotton.

Severe damage to cotton is caused by plant bugs. The pyrrhocorids and the pentatomids are the most important; but some damage is also caused by various species of mirids, lygaeids, and coreids. An average of about 20 percent of the bolls were found injured owing to the boll-feeding habits of various species of hemipterous insects.

Several species of scale insects and mealybugs are also found on cotton, but they never become numerous enough to attain an economic status. It appears that these insects become abundant on cotton only when the plant is a perennial, and thus a longer period for the spread of the colonies is provided.

Although the cotton aphid is widely distributed it causes but little damage. Heavy rains, numerous predators, and parasites are effective checks on its abundance.

Several species of leafhoppers puncture the stem and leaves, from which they extract large quantities of sap; but the plant seems to withstand this loss, and injury from these insects is apparently slight.

The West Indian mole cricket and a soil-inhabiting cutworm occasionally menace the stand of young seedling cotton.

The West Indian blister mite is a major pest. The development of fruiting forms may be entirely prevented if the attack begins on the young growing plants.

Various species of snout beetles, leaf beetles, thrips, and lacebugs are found on cotton. A leaf miner and a stem borer are also present.

The pink bollworm, the hemipterous insects, the West Indian blister mite, and the cotton leaf worm are the major cotton pests in Puerto Rico. Although the damage from any one of many other species is not extensive, the total damage from all has been considerable.

LITERATURE CITED

(1) Audant, A.
1933. la chenille du cotonnier (alabama argillacea hübner) en haiti. Cong. Internatl. Ent., Paris (1932) 5: 483–487.

(2) Ballou, H. A.
1912. insect pests of the lesser antilles. West Indies Imp. Dept. Agr. Pamphlet 71, 210 pp., illus.

(3) Camuñas, Manuel.
1921. a los agricultores de puerto rico y especialmente a los cosecheros de algodón. Rev. Agr. Puerto Rico 7 (3): 5–7.

(4) Catoni, Luis A.
1921. plagas de insectos que atacan la planta del algodón y como combatirlos. Rev. Agr. Puerto Rico 6 (3): 25–31.

(5) ———
1921. A LOS COSECHEROS DE ALGODÓN EN PUERTO RICO. Rev. Agr. Puerto Rico 7 (6) : 25–26.
(6) ———
1921. DOS PLAGAS DEL ALGODÓN QUE NO QUEREMOS EN PUERTO RICO. Puerto Rico Insular Expt. Sta. Cir. 41, Span. ed., 9 pp.
(7) ———
1922. INFORME DE LAS ACTIVIDADES DE LA CAMPAÑA DE ERADICACION DEL GUSANO ROSADO EN PUERTO RICO LLEVADA A CABO POR EL DEPARTAMENTO DE AGRICULTURA Y TRABAJO. Rev. Agr. Puerto Rico 8 (4) : 15–22, illus.
(8) CREIGHTON, JOHN T.
1936. ANOMIS EROSA HUBN. AS AN INSECT PEST OF COTTON. Jour. Econ. Ent. 29: 279–282.
(9) FIFE, L. C.
1937. STATUS OF THE PINK BOLLWORM IN PUERTO RICO DURING 1935–36. Jour. Dept. Agr. Puerto Rico 21: 233–235.
(10) ———
1937. THE PINK BOLLWORM OF COTTON IN PUERTO RICO DURING 1936 AND RECOMMENDATIONS FOR ITS CONTROL. Puerto Rico Agr. Expt. Sta. Agr. Notes 81, 9 pp.
(11) ———
1937. DAMAGE TO SEA ISLAND COTTON BY THE WEST INDIAN BLISTER MITE (ERIOPHYES GOSSYPII BANKS) IN PUERTO RICO. Jour. Dept. Agr. Puerto Rico 21: 169–177, illus.
(12) FOLSOM, J. W.
1932. INSECT ENEMIES OF THE COTTON PLANT. U. S. Dept. Agr. Farmers' Bull. 1688, 29 pp., illus.
(13) ———
1936. NOTES ON LITTLE-KNOWN COTTON INSECTS. Jour. Econ. Ent. 29: 282–285.
(14) FORBES, W. T. M., and LEONARD, M. D.
1930. A NEW LEAF-MINER OF COTTON IN PORTO RICO (NEPTICULA GOSSYPII NEW SPECIES). Jour. Dept. Agr. Puerto Rico 14: 151–157, illus.
(15) HOOKER, C. W.
1913. REPORT OF THE ENTOMOLOGIST. Puerto Rico Agr. Expt. Sta. Rept. 1912: 34–38.
(16) LEGRAND, J. FEDERICO.
1921. EL GUSANO ROSADO DEL ALGODÓN (PECTINOPHORA GOSSYPIELLA). Rev. Agr. Puerto Rico 7 (3) : 9–13.
(17) ———
1923. NOTAS DE INTERÉS. Rev. Agr. Puerto Rico 10 (4) : 49–54.
(18) LEONARD, M. D.
1930. RECOMENDACIONES PARA COMBATIR LAS PLAGAS DEL ALGODÓN EN PUERTO RICO. Rev. Agr. Puerto Rico 25: 135–136, 163–164.
(19) ———
1932. THE PINK BOLLWORM OF COTTON IN PORTO RICO. Jour. Dept. Agr. Puerto Rico 16: 65–73, illus.
(20) ———
1932. INSECT CONDITIONS IN PUERTO RICO DURING THE FISCAL YEAR JULY 1, 1930 THRU JUNE 30, 1931. Jour. Dept. Agr. Puerto Rico 16: 121–144.
(21) LUCIANO, JOSÉ.
1922. NOTAS DE INTERÉS. DATOS SOBRE LA CAMPAÑA EN CONTRA DEL GUSANO ROSADO DE LA CÁPSULA DEL ALGODÓN. Rev. Agr. Puerto Rico 8 (3) : 63–64.
(22) MELLADO, ANTONIO.
1935. CAMPAÑA PARA COMBATIR LA ORUGA ROSADA DEL ALGODÓN. Tierra y Patria 1 (1) : 28.
(23) ———
1935. ALGO SOBRE ALGODÓN. Tierra y Patria 1 (2) : 36–37.
(24) MORE, J. D.
1921. INSTRUCCIONES CONCERNIENTES AL GUSANO ROSADO DE LA CÁPSULA DEL ALGODÓN. Rev. Agr. Puerto Rico 6 (5) : 21–26.
(25) MORRILL, A. W.
1910. PLANT-BUGS INJURIOUS TO COTTON BOLLS. U. S. Bur. Ent. Bull. 86, 110 pp., illus.

(26) Pastor Rodríguez, Juan.
1929. el cultivo del algodón sea island. Rev. Agr. Puerto Rico 22: 157–158, 172.
(27) ———
1931. alarmante irrupción de la oruga rosada del algodón en el distrito sur. Rev. Agr. Puerto Rico 26: 174, 176.
(28) ———
1931. de las estaciones experimentales alrededor de la oruga rosada, (p. gossypiella). Puerto Rico Dept. Agr. y Com. Bol. Agr. 1 (6): 2–3.
(29) ———
1933. el cultivo del algodón sea island en puerto rico. Puerto Rico Insular Expt. Sta. Cir. 102, 33 pp., illus.
(30) Rainwater, C. F.
1934. insects and a mite of potential economic importance found on wild cotton in florida. Jour. Econ. Ent. 27: 756–761.
(31) ———
1936. occurrence of aphis medicaginis koch and anomis flava fimbriago steph. on cotton in south carolina. Jour. Econ. Ent. 29: 94–96.
(32) Saavedra, Emilio F.
1929. la oruga rosada de la cápsula del algodón en puerto rico. Rev. Agr. Puerto Rico 23: 207, 216.
(33) Smyth, E. Graywood.
1920. cotton insects in porto rico. Ent. News 31: 121–125.
(34) Torres, Ignacio L.
1929. algo sobre algodón sea island. Rev. Agr. Puerto Rico 22: 90–93, illus.
(35) ———
1931. campaña contra el gusano rosado del algodón. Rev. Agr. Puerto Rico 26: 175–176.
(36) Van Dine, D. L.
1912. progress report on introductions of beneficial parasites into porto rico. Porto Rico Bd. Comm. Agr. Rept. (1911–12) 1: 31–47.
(37) Wilson, Charles E.
1923. insect pests of cotton in st. croix and means of combating them. Virgin Islands Agr. Expt. Sta. Bull. 3, 20 pp., illus.
(38) Wolcott, George N.
1922. the distribution of the pink bollworm of cotton, pectinophora gossypiella saunders, in porto rico. Jour. Econ. Ent. 15: 313–314, illus.
(39) ———
1922. informe sobre un viaje hecho a la región algodonera para observar las plagas de insectos que atacan al algodón. Rev. Agr. Puerto Rico 9 (3): 15.
(40) ———
1923. the distribution of the pink bollworm in porto rico. Porto Rico Insular Expt. Sta. Cir. 85, 7 pp., illus.
(41) ———
1931. the infestation of young okra pods by pink bollworm in porto rico. Jour. Dept. Agr. Puerto Rico 15: 395–398.
(42) ———
1933. an economic entomology of the west indies. 688 pp., illus. San Juan.
(43) ———
1936. "insectae borinquenses" a revised annotated check-list of the insects of puerto rico. Jour. Agr. Puerto Rico 20, pp. 1–627, illus.
(44) ——— More, J. D., and Seín, F., Jr.
1921. la oruga rosada de la cápsula del algodón en puerto rico. Puerto Rico Insular Expt. Sta. Cir. 63, 12 pp., illus.
(45) ——— and Seín, F., Jr.
1931. la oruga rosada de la cápsula del algodón en puerto rico. Puerto Rico Insular Expt. Sta. Cir. 95, pp. 1–13, illus.

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